Fast 3D Finite Element - Boundary Element Analysis of Induction Heaters with Passive and Active Shielding

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Induction heating devices are used for thermal treatment of conducting workpieces. This thermal treatment is achieved by eddy currents due to strong alternating magnetic fields. Passive and active shieldings may be employed to mitigate the magnetic field in the whole surrounding area and reduce the hazardous exposure of both the human operator and the electronic equipment. The design of the shielding must minimise any modification of the thermal process [1].

This paper deals with an accelerated hybrid finite element–boundary element (FE-BE) simulation of such an induction heater. See the experimental setup and its 2D axisymmetric geometry in Figs. 1 and 2, respectively.

A hybrid FE-BE model is particularly suited for solving open electromagnetic field problems that comprise eddy currents [2]. The FE method easily accounts for conducting media, while the BE method provides a rigorous treatment for open problems. A significant disadvantage of the hybrid FE-BE model, compared to a pure FE model, is that the BE part leads to fully populated blocks in the matrix of algebraic equations. This limits considerably the size of the problems to be handled. This limitation can be overcome by applying the Fast Multipole Method (FMM) to the BE part of the hybrid model [3].

In the full paper the authors will discuss and illustrate the application of the FMM to a 3D eddy current problem, using an hybrid FE-BE model. Numerical results will be compared with results of a 2D axisymmetrical FE model and measured data. The computation cost and memory requirements will be discussed showing the efficiency of the FMM.

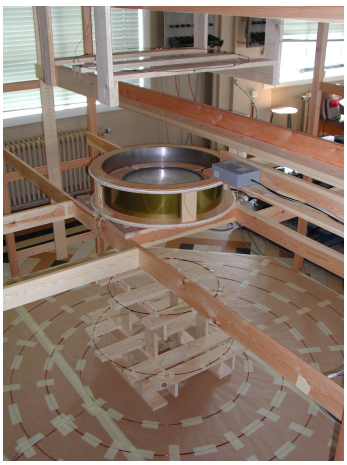

Fig. 1: Experimental setup of the induction heater

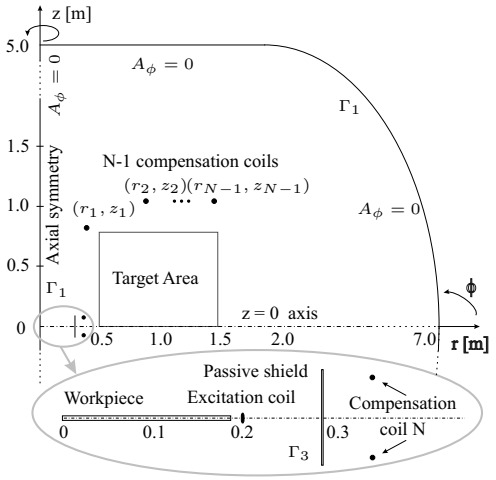

Fig. 2: 2D axisymmetric lay out

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